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A model for instructional integration for science and English-language development

Patricia Diane Andreano

A MODEL FOR INSTRUCTIONAL INTEGRATION FOR SCIENCE AND ENGLISH-LANGUAGE DEVELOPMENT

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

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by

Patricia Diane Andreano

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September 2005

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ABSTRACT

This project recommends a professional development model for the integration of language arts and science skills to improve the literacy and scientific proficiency of elementary students, specifically English language learners. Through the information researched, this model will give direction for the integration of science and language arts, and discuss strategies where schools have implemented similar models. The study also suggests limitations, and areas for further study.

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Permission to use portions of the *Aquatics Habitats* guide was made possible by the following:

DEDICATION

To Lisa and Paul,

and to those who are watching from above.

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CHAPTER ONE

A MODEL FOR INSTRUCTIONAL INTEGRATION FOR SCIENCE AND ENGLISH-LANGUAGE DEVELOPMENT

Introduction to the Project

Mathematics, science, and technology are critical to the economy, security, and innovative leadership that the United States has dominated from the Industrial Revolution to the Informational Age (Business-Higher Education Forum, 2005). As the workplace becomes more technologically complex, people must have greater math and science skills, and this is true in all sectors of the economy. In the future, an increasing number of jobs will require high school degrees, and at least some post secondary education requiring higher levels of math and science skills (Northwest Regional Educational Laboratory, 1997; BHEF, 2005). Increasingly, the greatest opportunities will be found in services and technology that will require significant knowledge in science and math. Many of today's students will be under prepared in these areas (NWRE, 1997).

In the past, employers have filled positions with foreign students who have studied in the United States, and remained for work opportunities in this country.

Increased global competition for skilled scientists and mathematicians has found countries competing for their own students, and investing heavily to ensure their scientific and mathematically talented students remain to fill their own work force. No longer can the United States depend on the small number of elite students entering science and math classes at the university level, or foreign students who have found difficulties remaining in this country due to security issues since 9/11.

Everyday matters require some knowledge of math and science for citizens to make informed decisions about their health, the environment, and complex issues that involve reasoning skills developed in science (Northwest Regional Educational Laboratory, 1997). Science allows people to understand and appreciate the natural world, gives them background information to make educated decisions, and empowers them with problem-solving and critical thinking skills necessary to help them in their personal lives and their professions (National Academy Press, 1996 p.1). The next generation will need a greater knowledge of math and science than was required by their parents in their everyday decision making and their careers.

It can be seen, then, that science education should be accessible for all students, even those who, in the past, have been from under represented groups in the population. In addition to women, students of color, and those whose primary language is not English are needed to fill rapidly increasing numbers of jobs requiring backgrounds in science and mathematics. As stated in the National Science Education Standards, "The diversity of today's student population and the commitment to science education for all requires a firm belief that all students can learn science," (National Academy Press, 1996 p. 29), "...and that all students deserve and must have the opportunity to become scientifically literate" (National Academy Press, 1996 p. ix).

This commitment to strengthening math and science skills for all students becomes more challenging for teachers as they try to meet the needs of a population of students that is becoming increasingly diverse, culturally and linguistically (Lee, 2002 p. 65). Teachers must make content comprehensible for students with varying educational backgrounds and skills, including those students who may be learning English as their second language. Although educational standards stress science for all, it is not altogether clear how this is best accomplished when faced with a range of diverse student needs.

Further exacerbating the problem is the emphasis on accountability, especially in literacy and mathematics. Expectations for performance proficiency on state and national assessments have increased in recent decades; the push for accountability is without comparison today (Amaral, 2002). With the emphasis on reading, writing, and math, there has been a decline in the number of hours available for science instruction. As cited in Lee and Avalos (2002), the United States Department of Education reports most elementary schools allocate over two hours per day to literacy (reading and writing) and one hour for math, and approximately one hour per day divided between social studies and science. This has translated into little or no science being taught at the elementary school level.

Due to the pressure to do well on state and national assessments many English language learners are not receiving the science content called for in the science standards. For most English language learners, especially in the elementary grades, the pressure to become fluent and attain literacy levels that approximate native speakers at their grade level, means that many will not be engaged in science classes until they have reached fluency (Lee & Avalos 2002, p. 8). There are 1.4 million English language learners in California. More than 40 percent of the students in California speak a language other than English, and about 25 percent, or one in every four of the students in California are not fluent in English (California Department of Education 2002, p. 11) and are classified as Limited English Proficient (Fillmore & Snow, 2003). For many of these students it means that unless they are better prepared in the elementary grades in mathematics and science, they will have such difficulties with middle and high school science classes that it will be impossible for them to meet the demands in courses necessary to further their education and obtain challenging work.

It is up to the teacher to decide how to teach the science content and process skills in such a way as to make them comprehensible to all students, even those still learning English. Science education involves its own vocabulary, style of inquiry and writing, and academic language that are difficult even for students proficient in English. Science texts are formidable for most students. It is critical for English language learners to participate in science classes because it builds their vocabulary, leads to literacy and English proficiency, and develops communication and critical thinking skills, as well (Lee & Avalos, 2002, p.3). Adding science to state assessments provides one more reason for teachers to look at science instruction in terms of meeting the needs of all students. As quoted by Dobb (2004, p.5)

Science education is intended for all students. Academic instruction must be designed so that each student has the opportunity to master science standards that provide systematic and coherent access to this challenging subject. Instruction for English Learners in the academic language of science is critical and must be specifically designed, planned, and taught.

Purpose of the Project

Language proficiency is measured by the California English Language Development Test (CELDT). For students to be reclassified as Fluent English Proficient they must be able to read at grade level, pass a writing sample, and perform listening, speaking, and writing skills as assessed on the CELDT test. Many students in the Ontario-Montclair School District are able to master earlier levels of proficiency, but have difficulty mastering the advanced levels. One possible reason is that the students are not developing the academic language found in the content areas, especially science. This lack of academic language also hinders them because English language learners are expected to take the state assessments in language arts, math, and science (in the fifth grade) regardless of their level of language proficiency. Science instruction can provide opportunities for students to engage in learning about their natural world, promote communication and reasoning skills, and give authentic opportunities to write and build vocabulary necessary for academic language development.

The purpose of this project is to recommend a professional development model that integrates thirty minutes per day of English Language Development (ELD) time, and approximately three and a half hours per week of science instructional time in a way that supports both science content and English Language Development.

Scope of the Project

To plan the science instructional time in this model, the California Science Standards along with the state blueprint for the STAR fifth grade science test can be used to determine the content. In the English language development (ELD) instructional block, the *English-*

Language Development Standards for Public School: Kindergarten through Grade Twelve (California Department of Education, 2002) and the CELDT test suggest objectives for students in a range of language proficiencies from non-English to fluent English proficient.

In order to make the content more comprehensible the model utilizes four lessons from an alternate teaching guide that covers the same science standards in a less restrictive and more collaborative style than described by the district adopted text. Throughout the unit, however, the text is used to support instruction, and is part of the assessment.

Language and study skills using the text are supported during ELD time, as is vocabulary. Students can keep science notebooks, write and ask interview questions, develop a collaborative story, and produce posters for the community on the subject of the unit during ELD time. Field experience can be attained through a field trip to a regional park or conservation district watershed site.

Significance of the Project

Most school districts have only one science text adoption, regardless of the reading ability of the students. Finding alternative materials for English language learners in grade level content is hindered by the availability of materials and cost. Most teachers in the Ontario-Montclair School District are expected to use the adopted English Language Development program, and may not be released from that requirement in order to develop integrated science units for ELD.

The project suggests combining ELD and science instructional time to develop an integrated theme and model of instruction. It is an opportunity for students to engage in a variety of language skills in an authentic manner. The model outlines how teachers working in grade level teams plan and coordinate science units that teach content standards, and make it possible for all students to participate in science activities, in spite of their varying language proficiencies. With the additional thirty minutes available through ELD, it is hoped that all students will be able to access resources and learn content previously considered inaccessible to English Language Learners. The model allows the instructor to apply research in both science teaching practices and academic language development for English Learners.

Definitions of Terms

The model assumes English Language Learners (ELL) and English Learners (EL) will describe students acquiring English language skills after first speaking in a primary language other than English. The California English Language Development Test (CELDT) tests English language learners for English proficiency in listening and speaking, reading, and writing. RSP will denote a resource specialist program that provides instructional assistance to children with learning disabilities. CLAD is the Cross-cultural Language and Academic Development certificate earned by teachers who have received instruction designed to teach children who are English language learners.

Content-Based ESL has the primary goal of English language development, using ESL methods, and may be taught in a variety of thematic units, while Sheltered Content Instruction provides strategies to enable ELL students to comprehend the academic subject, such as science. SDAIE refers to Specially Designed Academic Instruction in English strategies that modify instruction in content areas to meet students' diverse language and cultural needs.

CHAPTER TWO

LITERATURE REVIEW

Introduction to Literature Review

Literacy is the ability to use reading, writing, and oral language to learn and communicate. Obtaining strong language arts skills makes it possible for individuals to access knowledge in other content areas, and to be confident when communicating orally and in writing. Today, schools are extremely concerned with the ability of all of their students to acquire these skills. As stated in a research paper by Johnson (2002, para. 12), "teachers and school administrators are facing enormous pressure to improve test scores of students in their schools in the basic skill areas of math and language arts."

Statistics from the National Adult Literacy Survey, conducted by the United States Department of Education, as quoted in Hurley's research paper (1998, p. 1), prove that literacy problems can continue into adult life. As our English language learner population continues to grow, so will the problems of literacy if immigrant students do not gain English fluency in school. As described in Johnson (2002, para. 13):

Teachers and school administrators are facing enormous pressure to improve test scores of students in their schools in the basic skill areas of math and language arts. Schools are reducing the amount of time and resources devoted to science education, to focus on improved achievement on math, reading, and writing assessments. This leads to increased fragmentation of science from math and language arts.

This crisis in literacy threatens to severely diminish instruction in content curriculum area (Thier, 1999). Many teachers and administrators fail to see the value in teaching science in elementary classrooms although there are national standards that emphasize science should be taught in all grades, from Kindergarten to high school (National Research Council, 1996).

With rigorous literacy and numeracy standards, and high-stake testing accountability, this literature review locates research that produces information concerning the possibility of integrating science and language arts instruction with particular emphasis on the needs of English language learners.

Review of Literature

With a national push for accountability, and the dominant role of standardized tests in determining student progress, many teachers have been told to focus instruction on language arts and math skills, and others have been told not to teach science in the primary grades, at all (Akerson, 2000). Those teachers who make time to teach science, feel there is too much to cover, and that content becomes "spread too thin" (Hurley, 1998). In fact, science and language arts are viewed as competing with each other, and the challenge is to find ways to include science instruction without losing the emphasis on literacy skills (Century, 2002).

The problem is intensified for teachers with English language learners in their classes. Without English fluency, students will struggle in content classes as well as in language arts. Teachers are not always prepared to meet all of the different needs of English language learners, although the students are expected to learn grade level content along with English proficient students (Fillmore & Snow, 2000).

In *Classrooms that Work: They Can ALL Read and Write* (Cunningham & Allington, 2003), the authors differentiate between skills that we learn, such as reading, writing, singing a song, playing ball, and knowledge which are things that we know. They feel that schools are emphasizing skills to the demise of content knowledge. When children reach the upper elementary grades where they are expected to read, comprehend, and write in science and social studies, they lack the prior knowledge needed to access these skills. Furthermore, many standardized test questions expect children to read and comprehend in content areas that are unfamiliar to students, reflecting in lower test scores. This occurs because many children learn to read stories, rather than nonfiction materials, and lack the real experiences that help build comprehension.

Cunningham describes how children need as many real experiences as possible, such as field trips, realia, pictures, videos, and hands-on inquiry-based science activities to supply them with the real world experiences they need to draw upon for comprehension. Cunningham & Allington (2003) encourage elementary teachers to transfer the literacy practices that they use in language arts blocks, to content areas. There, students will be writing to observe, describe, communicate, categorize, predict, report, etc., while developing content concepts at the same time. Science can be the motivator to encourage students to seek fiction and nonfiction reading materials for explanations and background for self designed investigations. Many children are alliterate: choosing not to read despite good reading abilities. Reading in content areas may motivate them to read. The more children read, the more proficient they become as readers.

Likewise, in *Guiding Readers and Writers: Grades 3-6*, Fountas and Pinnell (2001) discuss the importance of teaching literacy skills to students learning to read texts in science and social studies. Because of the style of writing, the vocabulary mastery, and items that enhance the text like graphs, tables, charts, and diagrams, many language arts skills can be honed in content classrooms. Furthermore, writing in the content areas allows for different genres than may be found in language arts classes.

Thier (1999) believes strongly in the reciprocal support that literacy and science give to one another. Both science and literacy require children to observe, compare, contrast, predict, sequence, make inferences, draw conclusions, discover fact and opinion, communicate, and develop meaning (Thier, 1999; National Research Council, 1996). Students experience writing genres that are essential to content areas, but may not be part of the language arts class. Thier is particularly interested in the ways that science and language arts can be integrated in inquiry-based hands-on experiences. Removing the textbook, and replacing it with activities that children can experience themselves, is important for children who are developing literacy skills. It allows them time to build associations between the real world and the abstract (Thier, 1999; Lee & Avalós, 2002). Thier also suggests strategies such as creative writing and poetry to stimulate imagination.

Instead of completing yet another round of worksheets and workbook pages, science can engage children in authentic writing, listening, and speaking skills such as noting details in their journals or notebooks, sharing their findings with peers, writing descriptions, focusing on details, looking for likenesses and differences, predicting, sequencing, evaluating facts and opinions, making inferences, understanding new words and their meanings, asking questions, and drawing conclusions. Extensions may include graphing, writing letters of persuasion, writing expository essays, role playing, presenting oral presentations, applying problem-solving techniques, and using critical thinking. Many of these skills are embedded in both language arts and science, and are sound practices recommended for developing language fluency for English language learners (Campbell, 2003).

Science also gives children common experiences to talk and write about, and opportunities to communicate with their peers, and their teacher. Teachers can use the language arts skills to help them to formatively assess students, to plan for subsequent lessons, and to develop questions that will guide their students through inquiry lessons (Johnson, 2002; Stoddart, 2002; Krueger, 2001; Campbell, 2003).

While there is agreement with other authors as to the value of writing in science, especially journal writing (Shepardson & Britsch, 1997; Campbell, 2003; Tierney, 1996), Keys (1999) has expressed a concern for the lack of experience in transactional forms of writing in science. Transactional writing is consistent with "writing to inform" or "writing to communicate." Rather than developing poetic or narrative writing in science, the author is advocating the development of transactional genres to describe experiments, explain concepts, report, give evidence, or study scientists through biographies. Science provides unique opportunities to address these styles of writing, while leaving poetic and narrative writing to language arts.

As the literature has shown, there are possibilities for language arts to be integrated with science. Further research for this model describes the importance of having experiences that develop from inquiry-based instruction, where students support the questions they develop with research and activities of their own design. A particularly important part of this literature, is the focus on inquiry as opposed to teacher-directed and textbook-driven science instruction (Century, 2002). Inquiry is seen to provide a richer use of the language, while developing written and oral communication. Also, when reading is part of the inquiry program, it is deemed critical that it be comprehensible for the students, and aid in achieving a greater understanding of the science concepts and not just be useful to answer the chapter questions (Akerson, 2001). Preparation like this enables upper elementary and middle school students to use resources with greater ease and comprehension. The most important aspect of inquiry-based instruction remains its active engagement of the students. This is seen as critical for concept building for today's students, many of whom have not had the contact with the natural world that previous generations experienced (Allen, 1997; Donovan, 1999).

The final area to consider for this model involves research regarding English language learners in the content areas. Research in this area has contributed to the design of a successful integrated language-arts and science model on ecosystems for the fourth grade.

Amaral (2002) provides documentation for a program involving students in El Centro, California. Approximately 600 students in fourth grade, and 600 students in sixth grade were tracked over a four-year period. The study followed students who had been enrolled in traditional, textbook science instruction, and students participating in inquiry-based hands-on instruction using science kits. Each grade level taught only four units per year, primarily in English, with special instructional support. At the end of the four-year study, it was found that increases in standardized test scores in language arts, reading, math, and science directly correlated with the number of years students participated in the inquiry program. District writing samples also improved dramatically. Important elements of this program are the commitment to high quality curriculum, substantial professional development for teachers and administrators, district support for the physical needs of the program, and on-going assessment and evaluation (Amaral, 2002).

These results were profound because the El Centro School District is a rural community, with most families living at the poverty level, and approximately 81% of the students classified as English language learners. The district concluded that using the inquiry-based science materials provided ELL students the freedom to communicate with peers, work on problem-solving activities in comfortable situations, develop writing and reading skills for a purpose, and develop cognitive skills in content areas where ELL students were often not included (Amaral, 2002).

Another study in Santa Cruz, California, related similar outcomes (Stoddart, 2002), adding that ELL students are often lost in a text full of meaningless words in the content classrooms, and that learning language is possible in situations where authentic experiences give students opportunities to dialogue with peers and teachers. Furthermore, scientific literacy (the ability to use science knowledge in everyday situations) also increases.

In research reported by Lee (2002) and Lee & Avalos (2002) the authors consider the roles played by educational programs and teachers in integrating science and literacy for all students, but specifically English language learners. They state that English language development programs, and educational policies and practices can limit access to science for ELL students when opportunities to content classes are denied based on a child's English language fluency. Most ELL programs focus on literacy at the expense of other subjects, and therefore an ELL student may gain in general literacy, but not be learning the academic language necessary to succeed in higher levels of education. They also uphold the belief that science instruction helps ELL students to develop literacy by making connections between the real world and the abstract world. It is important for science teachers to make the connections between the big ideas of science and the child's community, as many children do not have the science background necessary for content and literacy skills. Participating in hands-on science investigations encourages children to communicate orally in their primary language or English, while at the same time acquiring content (Lee, 2002).

In order to have the necessary materials to support a diverse group of students, teachers may need to create their own resources, or be prepared to change materials that come in science programs to fit student needs. This requires substantial commitment to staff professional development for teachers of English language learners who may not have the science background, and regular mainstream teachers who work with students who do not speak English and need scaffolding strategies.

Writing for the California Science Project, Dobb (2004) supports the idea of the language-rich environment of the science classroom as a place for all students to learn academic language. He upholds the belief that shared experiences allow English language learners to develop understanding of science concepts by making language meaningful through inquiry science. Learning the specific patterns of scientific discourse, and developing the academic vocabulary may help students achieve over-all academic achievement, as "standardized tests favor students with well developed vocabularies," Dobb (2004, p. 21). Vocabulary development progresses as students move towards fluency, with the goal of being redesignated as fluent English proficient. Many ELL students do not move beyond early intermediate or intermediate levels of English proficiency, and struggle in mainstream classrooms because of inadequate preparation in the mainstream classroom. When these students reach middle and high school, they are unable to succeed in demanding content classes, although they may appear to be fluent in their conversational English (2004, p. 11). Without assistance, they may drop out of school, fail to reach post-secondary educational levels, and have limited occupational choices (Business-Higher Education Forum, 2005).

Teachers need to be trained to use textbooks effectively, be able to use alternative materials that are more comprehensible for struggling students, and plan explicit instruction in literacy to help students access information, and to communicate orally and in writing. Without instruction, engagement with the text and comprehension will be low, and students will not become familiar with the vocabulary, text style, and features of expository writing.

In planning instruction, science teachers are expected to consult both the *Science* (2000) and *English-Language Development* (2002) *Content Standards for California Public Schools* guides in order to plan both content and language objectives to maximize the opportunities in both literacy and inquiry-science (Dobb, 2004). Supporting the development of scientific vocabulary and academic discourse, Sutman (1986) also includes the need for nontechnical vocabulary such as "time order" words, and those needed to express process skills. Fillmore (2000) also substantiates the need for direct instruction for academic language, and also advocates interaction between students and the teacher in order for students to practice discourse patterns that may be different from those used at home.

Through the literature reviewed, it is possible to see many opportunities to integrate science and language arts skills. Not only do they have objectives that overlap, they also create opportunities for children and teachers to apply skills learned in each discipline. As stated by Krueger, "Reading, writing, and science are, or should be, inseparable. Many of the [science] process skills needed for science inquiry are similar to reading skills, and when taught together reinforce each other" (2001, p. 52). The research not only provides a reason to integrate science and literacy, but provides a roadmap by which a professional development model can be constructed and implemented in a school district such as in Ontario-Montclair School District.

CHAPTER THREE

METHODOLOGY

Introduction to Methodology

The purpose of this project is to respond to data collected from Ontario-Montclair School District's state and district assessments. During the review of this data, the greatest concern is the performance of our English language learners. In discussing ways to help this subgroup to improve on the state assessments, it is important to note that many students have moved from beginning to early intermediate and intermediate levels of re-designation, but many are failing to reach fluency levels at advanced stages on the CELDT test. At the advanced level they would perform as well as native English speakers in language arts, and also capable of the same challenging content in math, science, and social studies. In fact, it appears that "the challenge" of the content areas might be preventing these students from developing the academic language needed to reach fluency.

With 120-150 minutes per day mandated for literacy instruction in English, a minimum of 60 minutes per day for math, and 30 minutes per day for English language development, approximately 90 minutes are left, four afternoons per week, for all other subjects including PE, social studies, and science. Assemblies, music and art are also part of this instructional block. The question is what kind of instructional model is possible to integrate English language development and science to give students an opportunity to increase their academic language skills, and improve their comprehension of science content? Can this model also help students to achieve the skills necessary for the CELDT test, and STAR science test given in the fifth grade?

Background Preparation

The first step in developing the professional development model was to interview the Teacher on Assignment (TOA) who is responsible for administering and scoring the CELDT test. His input helped to determine what skills are necessary to reach the more advanced levels of proficiency, and what skills might be included in an integrated science unit. It appears that the students at our school are more capable in the listening and speaking sections of the test, and are in need of support in reading, and especially writing. Also, vocabulary is impeding many students and is considered a critical area. Literacy skills already being taught in language arts, require application in the content areas. Prefixes and suffixes, word roots, grammar and syntax, multiple word meanings, sequencing, expository writing, time order words, following written and oral directions are examples that could be incorporated into science instruction. The collaborative nature of the science classroom can give students an opportunity for listening and speaking in authentic dialogue.

The *English-Language Development Standards for California Public Schools: Kindergarten Through Grade Twelve* (California Department of Education, 2002) and the Skill Area Proficiency Level Descriptors, Grades 3-5, can be downloaded from the California Department of Education (http://www2.ctb.com/state/CA/celdt/formd/index.shtml) and are being used as guidelines for the ELD portion of any integrated science unit a teacher might develop. Also from the California Department of Education, the California Standards Science Test for Grade Five was retrieved, as well as samples of the released science questions from the test (http://www.cde.ca.gov/ta/tg/sr/resources.asp). By comparison, there were more questions from the fourth grade life science strand on the fifth grade test, than from physical or earth science; therefore, life science was selected for the focus of this professional development model (see Appendix A).

The Ontario-Montclair School District has adopted *Harcourt Science Program* (Harcourt, 2000). This text was reviewed for vocabulary, lesson content, assessments, and Specially Designed Academic Instruction in English (SDAIE) support to see how these elements could be incorporated into the model. Because the text is considered difficult reading for most ELL students, and the SDAIE support is insufficient for the range of abilities in the average Ontario-Montclair School District classroom, an alternate resource, *Aquatic Habitats* (Barrett & Willard, 1998), was selected to introduce the integrated life science unit as a part of the model. However, the text can be used as a guide for vocabulary, and as a resource for content of the unit, and as one of the assessment tools.

Vocabulary development is considered essential to the integrated unit, as many of the students lack sufficient academic vocabulary for thorough comprehension in language arts and the science. Using the vocabulary from the text and *Aquatic Habitats* (Barrett & Willard, 1998), as well as a list of science words recommended in the Ontario-Montclair District Curriculum Guide, a list of potential vocabulary was developed for use in the model. The list includes words specific to the integrated unit, such as decomposer, herbivore, and habitat. Next, added to the list were science and math words that would be useful in multiple grade levels: describe, observe, record, investigate, measure, graph, label, etc. Some words were included for students who are generally considered beginning and early intermediate language learners, such as living/nonliving, female/male, survive, shelter, skeleton, etc. Finally, a list of words were created for English language development activities and mini-lessons including words with multiple meanings (scale, foot, table); synonym and antonyms useful in expository writing (light/heavy, rough/smooth; feel/touch); common instruments and household items children do not know the names of, like thermometers and measuring instruments; and terms students may have used in language arts that apply to science content, such as inference, cause/effect, contrast, identify, predict, sequence, etc. Additionally, several root words, prefixes, and suffixes are included. For a partial list of suggested vocabulary words, see Appendix B.

Alternate Resources

When selecting alternate and supplemental resources, they are selected to enhance comprehension of the science content, and/or to develop English language skills. Permission to use the GEMS guide, *Aquatic Habitats*, in this model was granted by Lawrence Hall of Science, Berkeley, California. *Aquatic Habitats* was selected because it supports the selected life science standards, is very engaging to students, allows students to create model ecosystems that can be observed over the entire period of the unit, is collaborative science and thus provides the EL student with multiple occasions to practice scientific discourse. At the same time students can develop their English language skills. There are also many opportunities for students to engage in literacy activities, including recording their observations, making predictions, asking questions, and journaling in their science notebooks. Also included, is an opportunity to write and ask questions when, for example, a guest speaker from the West Valley Vector Control Department speaks to the class. A summary of the activities from *Aquatic Habitats* will follow in the next section.

Children's literature also helps to develop both the science content and language skills in this model.

Nonfiction books from the Heinemann Library series of science books such as *Mosquito* (Bailey, 1998), can be used to teach children how to use nonfiction resources, as well as to develop their knowledge about various animals and their roles in the ecosystem. The classic *Trumpet of the Swan* (White, 1970) is included as a part of the model because the setting takes place in a pond, and more importantly, because one of the characters keeps a daily journal and excerpts are included in the story, modeling how the character records observations, and the kinds of questions he includes. *Pass The Energy, Please!* (McKinney, 1999) develops the idea of a food chain, and extends the idea of the food pyramid and the roles of producers, consumers, and decomposers into other habitats in pictures as well as text that is more comprehensible for students.

Summary of Project Activities in the Professional Development Model

It is suggested that one week prior to teaching the unit, the teacher organize student work groups of approximately three members each, and the students prepare the tanks that will become the ponds. During their science time, the student teams are asked to measure the outside dimensions of the tanks, and find the volume. Then the students are given gallon containers of water, and measuring cups, and asked to record how many cups it will take to fill the tanks.

Next, the groups follow written directions on how to gather their materials, and then measure and add the sand and gravel to the tanks. Then the students select plants to represent the producers. Elodea is specified in the guide. Finally, the children position clear plastic cups and flower pots for shelter in their ponds, and add the chemicals to dechlorinate the water.

On the same day during ELD time, the students take a pretest from the text covering the same science content standards that would be taught during the integrated unit. In addition, the children are asked to draw a picture of a fish, label any parts they can name, and to write a paragraph about a pond picture showing living and nonliving elements of the ecosystem used later in the unit. These will be used, along with the science notebooks the students set up during this period, as pre-assessments as recommended in the National Research Council's *How People Learn* (2000).

The science notebooks consist of three-prong folders with various graph, white lined, and plain white paper which students can arrange however they feel fits their needs. Also, five copies of the *Aquatic Habitats* observation/prediction worksheet, and several copies of a vocabulary template worksheet are included. The vocabulary worksheet has squares for the students to illustrate vocabulary words, write the word, and define the word or use it in a sentence. Since ELD frequently occurs in the morning, the notebooks are already prepared for the science activity in the afternoon, and can be used at the close of the pond construction so students can reflect on what they have created as a group during that lesson. Also, students discuss during science what might live in that habitat, and record their predictions in their journals.

When the model integrated unit is carried out, the *Aquatic Habitat* guide recommends that the tanks be allowed to sit for about a week before introducing the animals, to allow sufficient time for the algae to grow. It is suggested, from past experience, that care be taken in selecting aquarium plants. Using the Elodea, as recommended in the guide, prevents the unwanted decay of plants that are not suitable for the tanks. The students may observe that the Elodea will introduce some small fresh water snails to the ponds, which the students will observe in later activities.

After the ponds are established, the student groups add live tubifex or black worms, and Gambusia fish. The Gambusia fish, also known as mosquito fish, may be obtained from vector control offices. Following each animal's introduction, students observe the animal's movement and record the students' observations in their science notebooks using sketches and writing. They are encouraged to make predictions, also.

During their ELD time on the first day, students learn how to date, title, and record entries in their notebooks, and how to do a double entry where the paper is divided vertically allowing students to record questions or observations on the left, and reflections, predictions, or answers on the right.

When conducting these activities teachers need to be aware that factors may appear that are not expected. These may include the death of fish from the shock of transporting them, the change in temperatures within a classroom, or improperly treated water in the ponds. These can also become opportunities for research, discussing cause and effect, making predictions, problem solving, observing and recording, creating graphs, requesting help from experts, and actually using both language arts and science skills in realistic situations.

Lessons during the first week will include adding the blood worms to the habitat, noting the unique adaptations that each animal has for aquatic life, and understanding that each has a niche in the pond, and plays a role in a food chain. Students use both English and Spanish to discuss what is taking place in their tanks, but should record in English in their notebooks.

During ELD time this first week, the focus is on student observations and questions, and how they should be recorded. It is very difficult to encourage the students to record during the hands-on part of the instruction in science, so the ELD block gives them the opportunity to reflect and write. Much of the students' discussion and questions are recorded on large chart paper, and later posted around the room for reference. At times it is necessary to revisit safety rules the teacher has established, and cooperative participation goals.

Also during ELD, the students engage in guided drawings of the fish, snail, and an insect. Rather than have students label the parts of the animals on a worksheet, they are asked to create their own drawing by following as the teacher gives oral directions and outlines in marker over a prepared sketch of an animal. Using math words like circle, oval, rectangle, etc. to describe overall shapes, the children draw and label the major parts of each of the animals. While participating in the activity, they use attentive listening skills, and are engaged in careful observations. The teacher should be prepared for the numerous questions asked by students about the parts and adaptations of each animal. It is helpful to have a piece of chart paper nearby to record student questions, as students do not have the ability or desire to stop and record in their notebooks at this time. These drawings may be labeled as "figures 1, 2, and 3" and added to their notebooks.

Only one new animal is introduced to the tank during the second week, and that is the mosquito in larval or pupal form. It is suggested that personnel from a vector control office be consulted for this activity. They are able to provide the students with information concerning the life cycle of the mosquito, and how it is associated with the transmission of diseases, such as the West Nile Virus. This will also ensure the safe introduction of the mosquito larvae into the ponds so that the children can observe how the fish are used to control the mosquitoes, and why the Gambusia fish are commonly known as mosquito fish. At this point the children will begin to see that a food web, as well as life cycles, can be dependent on animals not generally found to reside in that habitat.

During the ELD block of the second week, students will prepare interview questions to ask the visitor from the vector control office. Students may be interested in the type of work a vector control agent is engaged in, other animals they encounter, and what training they have had for their job.

Also during this week students are introduced in ELD to the special features of nonfiction resources. Since the text is often too difficult for ELL students, they are overwhelmed and unable to use some of the text parts such as tables of contents, glossaries, indexes, and chapter features such as titles, headings, bold print vocabulary, pictures, graphs, and captions.

Using a series of animal books from the Heinemann Library such as *Mosquito*, children select from different books all having the same format, but written about different insects, worms, snails, etc. The books contain colorful pictures and simpler text, but still inform the reader about the animal using scientific vocabulary. Using a prepared study guide, and working with a partner, if they so choose to, students are guided through the parts of the text, then answer specific questions about their animal. Later, this information can be shared in oral presentations to the class as students act as experts on their animals. As students work with the nonfiction resources, they also have opportunities to compare their books with the fictional books being read such as *The Trumpet of the Swan* (White, 1970) and other picture books.

Finally, glossaries for their student notebooks are begun in ELD. Limited to the vocabulary that is essential to this integrated unit, students write the word, define it or give an example, and then illustrate the word. Words such as *individual*, *population*, *community*, and *habitat* had been introduced during the science block, and can now be included into the notebook glossaries. Each day only a limited number of words relevant to the science activities are included and illustrated. During the rest of the unit nearly all of the words highlighted in the text become part of the students' working vocabulary.

Students are encouraged to write about any changes they observed, such as fry that had been born during the week, fish that had died, the use of the shelters in the tank, and how the water should be refreshed weekly.

During the third week students will not observe as many changes in the ponds as they did in the prior weeks. The ecosystems will stabilize. The students will be ready to move beyond engaging and exploring, and transition to other resources for explanations about the ecosystems and the ways the plants and animals are able to adapt.

Using pages from the workbook or a teacher-created study guide, students will use the text during the science block to answer questions about ecosystems beyond the pond. Also, students will study food chains and webs, and the energy pyramid. Their knowledge of producers, consumers, and decomposers transfers from the concrete experience of the ponds to the abstract narrative in the text.

The text is usually difficult for most of the students. During ELD instructional time students are given mini-lessons on how to use the study guides to pick out the most important information in the text. They also learn how to scan the lessons and use the bold-faced words which are also in the glossary. Questions follow each subheading to aid in comprehension, and many graphs and pictures also provide information. The third week involves a more intense use of the text and vocabulary that was developed in prior weeks, and less time spent reflecting or recording questions in the notebooks.

To balance the expository reading, a well known African fable called *Why Mosquitoes Buzz in Peoples' Ears*

(Aardema, 1976) may be read to the class. It will provide the students with an opportunity to discuss what importance the mosquito might have had to these people in order to write a story about it, and to investigate another ecosystem. For English language learners, the text gives the students an opportunity to practice listening skills for comprehension, and to listen to the patterns of the sounds in the story. As a class, the students can create a collaborative rewrite of the story entitled *Why Mosquitoes Don't Buzz in Fish's Ears!* Using a fable format, they may conjure up a tale explaining why mosquitoes are prey to the Gambusia fish.

The final week of the unit is for evaluation and extensions to the unit. The students take a post assessment including the same test they took the first week, and use another copy of the fish tank picture about which they wrote a paragraph.

During one of the remaining ELD blocks, students learn to read a flier from the Vector Control office concerning West Nile Virus; learn who is at risk of contracting the virus, and how to prepare their homes to eliminate mosquitoes. Students may also access the West Nile website and learn where the West Nile Virus was found in California in 2003-2004, and how humans and animals were affected by the virus.

During their science time, the class prepares and plans how to distribute self-created posters to inform people in their neighborhoods about how the mosquito transmits West Nile Virus. In this way students use their knowledge as a community service.

If possible, it is suggested that students attend a field trip to a regional park or conservation district flood control pond where the students would apply their knowledge of ecosystems, food webs, and other related science concepts at that setting.

CHAPTER FOUR

PROFESSIONAL DEVELOPMENT MODEL

Introduction to Professional Development Model

The integrated life science unit described in the methodology section, Chapter IV, should serve as the content for the professional development model for teachers in the Ontario-Montclair School District. It is estimated that the model is best used with teachers over the period of one week. Each week's activities in the integrated unit, is reduced to one day of activity in the professional development model. This can be accomplished by setting up each week's activity beforehand so that it is ready to introduce on the appropriate day.

Professional Development Model

Teachers need time, support, and continued research when planning a unit that integrates two or more standards-based subjects. It is necessary to look at English language learners as students on a continuum from non-English to fluent English proficiency. Textbooks frequently lack useful ideas and practical strategies for making science content comprehensible. A unique challenge facing the classroom teacher is aligning inquiry-based science instruction with the direct instruction used in English language development.

When planning for their own classroom, teachers need to select activities to support both language development and science content standards. It is recommended that the standards guides be used for this purpose. One essential element of the model is to ensure that teachers work in grade specific collaborative groups. These groups will discuss how science resources will be used, establish notebook routines, and how notebooks should be assembled.

During the professional development experience, teachers will be shown that laboratory time should be used for quick-writes, and that ELD time be devoted to extending and refining student writing, including predictions and questions about the integrated life science activity. It has been found that students struggling with vocabulary, grammar, and syntax can see writing as an impediment if it is taking time away from doing the science activity. These are appropriate subjects for mini-lessons in ELD, and can support what is being concurrently taught in language arts.

Teachers will be introduced to how sharing their own personal journal about the integrated life science activity serves as a model to students who are delighted to hear how the instructor sees the same activities. Students also see how a person can record their thoughts and observations, and the teachers experience the use of journals for professional growth (Vasquez & Cowan, p. 18).

What teachers will most likely see after being exposed to this model, is progress in their students' abilities to observe, describe, ask questions, and make predictions. Vocabulary will show remarkable growth especially with those words learned in conjunction with the model pond activities and the guided drawings. With the use of a word bank and the glossaries in their student notebooks, students are able to apply new vocabulary correctly in their writing. This can be especially evident if the teacher compares pre-assessment and post-assessment paragraphs about the pond ecosystem. On the pre-assessment students frequently just list some animals appearing in a pond picture, while on the post-assessment most students describe either the mosquito or fish life cycle or the pond food chain.

Teachers can also expect to see an improvement in problem-solving skills. Though children frequently do not view themselves as possessing abilities to influence decisions at the community level, through the unit's posters on West Nile Virus, students see that they can influence community attitudes.

Throughout the week of professional development, it is important that teachers have access to a variety of alternate resources to support content instruction, and that they participate in the hands-on activities to build confidence when teaching the unit. It is suggested that during the week, district specialists for instructing English language learners, as well as science mentors be available for specific strategy assistance.

In the afternoon of each day, grade level teams from individual schools should have the opportunity to reflect on testing data for all of their students. If feasible, teams may want to use professional growth time to group students by fluency levels while planning their unit. In this way students receive the same challenging content during science instructional time, but will receive literacy support appropriate to their fluency level in ELD.

Ideally, the last day of the professional development workshop should also include time for long-term planning for the school year, and assessing the materials available at their own school sites. Teams should review all of the science strands, and determine when they will be taught throughout the school year. If science kits are to be used, the teachers may want to plan how to equip and check out the kits in order for all teachers to have access to them during the school year. Long-term planning should also give team members an opportunity to select inquiry activities to support the fifth grade state science assessment at their grade level, and to become familiar with the variety of skills students are expected to master on the CELDT test to be redesignated as fluent English proficient students.

Looking at student data from state and district assessments, grade-level teams can begin to identify skills that will be taught during the integration of science and ELD. If staff development time is available, teams should meet throughout the school year, perhaps on a monthly basis, to assess student progress, and design assessments, including project rubrics, that consider science content and language development separately.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

In *A Commitment to America's Future: Responding to the Crisis in Mathematics & Science Education* (Business-Higher Education Forum, 2005), it is stated that every student's future depends on competence in mathematics and science, but the majority of American students are falling far below international levels on science assessments. Although there has been improvement, the students in many nations out perform American students, especially as they reach middle and high school. Unless this trend is turned around, our position as an international economic power, as well as our national security, may be at risk. Scientific literacy is also necessary for the workplace, and to enable citizens to make social and political decisions in an informed way.

As our nation demands greater accountability of education programs, schools are also facing increasing numbers of students with diverse backgrounds. Many students enter school with a non-English primary language, and have varied prior experiences with school; some have never been to school. In California all students receive instruction in English, and are assessed on state tests in English. Therefore, it is the practice in most schools to aggressively move children towards English fluency as early as possible. This entails mastery of listening, speaking, reading, and writing in English, approximating that of a native English speaker. Many times this means the focus, especially in primary and elementary grades, is on literacy skills, often to the degradation of content knowledge.

Recently, science has been added to the California state assessment, and has brought to light the difficulties associated with teaching science content to English language learners, and there remains the nagging question of whether the test is assessing student science knowledge or language skills.

Much research is available to suggest that students should not be denied access to science based on their fluency in English, and that science actually contributes to academic language development, a necessary part of a student's development towards fluency. The challenge for teachers is to find enough time to teach science when the emphasis is on literacy and numeracy. Also, many teachers don't feel as confident in their abilities to teach science as they do literacy.

Conclusion

There are integrated instructional models for science and literacy, and available research to guide schools in increasing the potential for learning for all students. The integrated model suggested in this project is based on research in both English language development and inquiry-based science instruction, and on instructor familiarity with the alternative materials suggested for use in the project. The use of English-language development time to support science content is controversial in that most schools are expected to use adopted English-language development programs, which propose to have integrated science and social studies into the program. Using ELD time allows the teacher more time to conduct inquiry-investigations and hands-on activities during science, but also provides the students the support in vocabulary development, expository writing, and nonfiction reading essential for content learning. ELD time is also beneficial to reflective writing, nonfiction support materials, and extension activities.

The professional development model proposed in this project, uses the information obtained from the California English Language Development Test (CELDT) concerning literacy skills needed on the continuum towards redesignation as Fluent English Proficient. Also, the content standards for science and English-language development, and the state science test for fifth grade. Although this project focused on the life science strand, the same model could be adapted for the other science content strands. The primary consideration is to make grade-level content comprehensible for all students, and to maximize student acquisition of literacy skills through science.

Limitations of the Project

Many teachers of English language learners have their CLAD certification, but are not fluent in all of the languages represented by the student population. Therefore, strategies rather than primary language support are depended upon to make content comprehensible to students learning in their second language.

Time allotted to science instruction must also be shared with social science, as well as P.E., assemblies, and other activities prohibited during language and math instructional time. The integrated instruction for this model is designed for one four week period of science instructional time during a trimester. That breaks down to approximately three periods per week of ninety minutes each for approximately 1080 minutes of instructional science minutes per month, and thirty minutes per day of English Language development time, five days a week for a total of 600 minutes per month. If the science block is shared equally with social science, it would allow the instructor to plan for four different integrated science-content themes. Some students are pulled from science and/or ELD to attend the Resource Specialist Program, to work with the bilingual aide, or for testing.

Most school districts have only one science text adoption, regardless of the reading ability of the students. Finding alternative materials for English language learners in grade level content is hindered by the availability of materials and cost. Most teachers in the Ontario-Montclair School District are expected to use the adopted English Language Development program, and may not be released from that requirement in order to develop integrated science units for ELD. If teachers are creating their own materials, they need time to do so, and would benefit from working with grade level members. Also, teachers need practical strategies such as those found in Echhevarria and Graves (2003), Gibbons (2002), and Herrell and Jordan (2004) to assist in making science content comprehensible for all students.

Finally, using multiple sets of standards to design integrated units that build on science experiences and language development may expend more time and cause more frustration than an individual or grade-level team may feel is worth devoting to such a project. However, it may be possible to have teams from several school sites work together, planning units for use by the entire district. One problem with this is that the units may become too general, in order to meet a broad range of students needs.

Recommendations

It is important to remember that science is an active process, involving many skills that are difficult to assess, even when the student speaks English. The nature of science involves problem-solving, communicating, and validating knowledge with evidence. If science is now a part of the state assessment, it should be allowed to remain a process, and not placed on a pacing schedule, scripted, or be dependent on a single program. That would remove the soul of inquiry from science.

"Students deserve highly skilled, committed, and supported teachers in mathematics and science at each level of schooling," (Business-Higher Education Forum, 2005). That requires that teachers have strong subject matter knowledge, professional commitment to growth and improvement, the desire and skill to help students to learn, and the support and resources to put research and planning into practice. To encourage teachers towards these goals, the schools and districts should encourage teachers through professional development programs. Among the many referenced in the research used for this project, was the California Science Project which also provides assistance to teachers of English language learners. National and state science teachers' conferences also present workshops on science integration.

The professional development model outlined in this project encourages teachers to work with members of other teams or departments, so that bilingual aides, Teachers of English to Speakers of Other Languages, and science content teachers can provide assistance to mainstream classroom teachers. Teachers can also work in lesson study groups to assist each other in strategies and integration of content. The time to plan programs may only include a grade-level team wishing to group students by language development needs during ELD time. By grouping students, the same science content may be taught, but the literacy needs will be met more effectively. One benefit to this arrangement is that teachers might begin with existing science materials, but focus on how they will support student learning differently. Teams can work together to design assessments for science and literacy, and purchase and organize resources so that they are available when needed. This is important support for teachers who do not feel comfortable teaching science.

Finally, after completing this project, it is advised to begin with yearlong goals to include literacy in each strand of science, but begin by planning one unit first. This project has provided one such integrated unit. Keep plans flexible, and be prepared to change plans based on student needs. Remain aware of the background of the students, and realize that many have not had the opportunity to experience hands-on or inquiry science activities. They may need to be guided through many experiences before they are able to assume the role of asking questions and planning for their own investigations.

APPENDIX A

FOURTH GRADE LIFE SCIENCE STANDARDS APPEARING ON THE FIFTH GRADE CALIFORNIA STANDARDS SCIENCE TEST

FOURTH GRADE LIFE SCIENCE STANDARDS APPEARING ON THE FIFTH GRADE CALIFORNIA STANDARDS SCIENCE TEST

The standards included the following:

2. All organisms need energy and matter to live and grow. As a basis for understanding this concept:
   a. Students know plants are the primary source of matter and energy entering most food chains.
   b. Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.
   c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.
3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:
   a. Students know ecosystems can be characterized by their living and non-living components.
   b. Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
   c. Students know many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.
   d. Students know that most microorganisms do not cause disease and that many are beneficial.

In addition to the life science strand, two questions appear on the state assessment from the Fourth Grade Investigation and Experimentation Strand:

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
   a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.

b. Measure and estimate the weight, length or volume of objects.

c. Formulate and justify predictions based on cause-and-effect relationships.

d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.

e. Construct and interpret graphs from measurements.

f. Follow a set of written instructions for a scientific investigation.

APPENDIX B

SUGGESTED SCIENCE VOCABULARY LIST

SUGGESTED SCIENCE VOCABULARY LIST

General Science		Words Specific to Unit
cause/effect	identify	adaptation
caution	investigate	biome
chart	label	carnivore
class	length	climate
classify	list	community
compare	materials	consumer
conclude	measure	decomposer
conclusion	mixture	ecosystem
contrast	number	environment
data	observe	food chain
demonstrate	organize	food web
describe	pour	herbivore
diagram	predict	larvae/pupae
eliminate	problem	metamorphosis
estimate	procedures	niche
evaporate	record	omnivore
experiment	research	photosynthesis
fact	resource	population
function	safe	predator
hypothesis	sequence	producer

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